Annual Project Summary

Mid-America Integrated Seismic Networks -VPI

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INVESTIGATIONS UNDERTAKEN

The Mid-America Integrated Seismic Network (MAISN), is a cooperative effort between the University of Memphis (CERI), St. Louis University, Virginia Tech, the University of South Carolina, the University of Kentucky, and the U.S. Geological Survey. The purposes of the MAISN are twofold:

1. provide scientists, engineers, public and private entities, emergency responders, and the media with rapid and reliable information about felt and damaging earthquakes within a timeframe that maximizes the utility of the information.

2. provide high quality data on a timely basis to the scientific and engineering communities for the purpose of improving:
   a) seismic hazard estimation for urban population centers and the lifelines and critical facilities upon which they depend
   b) estimation and measurement of strong ground motions
   c) our understanding of the basic earthquake process and seismotectonics of earthquake zones, particularly in intraplate regions.

The Virginia Tech component of MAISN collects high-quality seismic data in Virginia and adjacent parts of the Appalachian region. Research objectives include earthquake monitoring to maintain continuity of earthquake catalogs for seismic hazard assessment, studies of the seismotectonics of the region, earthquake source studies, wave propagation, and the temporal/spatial behavior of seismicity. Outreach objectives include development and maintenance of regional earthquake catalogs; and dissemination of information to federal/state/local governments, the engineering community and the general public.

RESULTS

Seismic stations in Virginia are shown in Figure 1. The Virginia Tech Seismological Observatory (VTSO) maintains and operates stations FWV, PWV, ELN, BLA and now VWCC. Figure 2 shows the new station VWCC, which will be permanently on-line in December 2005. VWCC is on the campus of Virginia Western Community College in

downtown Roanoke, Virginia. The VTSO stations are 3 component, short-period with 24-bit digitization. Strong motion ANSS station CVVA is operated and maintained by CERI: arrival time data from this station are routinely combined with data from the Virginia Tech network stations and other regional stations to locate shocks in central Virginia and adjacent areas. A new broadband station is being installed on the campus of the University of Richmond, and is expected to become operational in early 2006. This is the result of a collaboration involving Virginia Tech, University of Richmond and the City of Richmond.

Plans for 2006 are to relocate the equipment at PWV to the J. Sargent Reynolds Community College in Central Virginia, in a station configuration identical to that at VWCC. This station relocation and the new broadband station in Richmond will greatly improve detection capability and location accuracy for shocks in the central Virginia seismic zone, which in recent years has been much more active than the area in western Virginia where most of the VTSO network stations currently reside.

The VTSO digital network data are ported to an EARTHWORM system and are being exported to USGS NEIC in Golden, Colorado, and to CERI (University of Memphis, Tennessee). Virginia Tech and other collaborative member institutions of MAISN are committed to efficient data acquisition, analysis and dissemination under the auspices of the mid-America region of the Advanced National Seismic System (see website at **http://www.anss-ma.org**).

In addition to the data disemination via EARTHWORM, Va Tech maintains an anonymous ftp site containing waveform data from selected regional events. This is accessible via web browsers at **ftp://vtso.geol.vt.edu/events**. The worldwide web site **http://www.geol.vt.edu/outreach/vtso/** contains information on how to access the waveform data, as well as the other products of this project, which include a regional seismicity bulletin and historical earthquake catalog for the southeastern U.S. region. In addition, the website includes twenty-four hour digital Helicorder trace data from vertical components of the network.

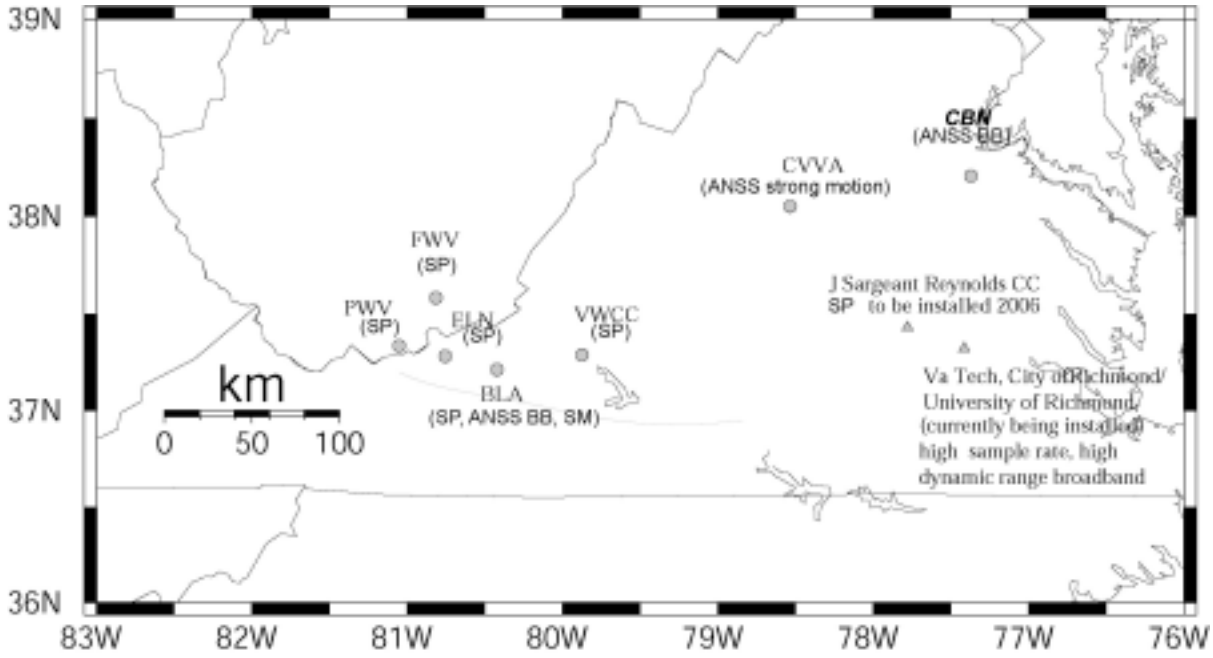

Figure 1. Seismic stations in Virginia.

Figure 2. (Left) photo taken from station VWCC showing radio receiver location on the roof of the Science Building at Virginia Western Community College in Roanoke, VA. (Right) The author (on the left) and trusty research assistant Jacob Beale assembling the seismometer vault. The station solar panels and steel equipment enclosure are mounted on posts visible behind us.

Recent Seismicity In and Around Virginia

Figure 3 shows the epicenters of earthquakes in the Southeastern U.S. during the period 1/1/2004 through 9/30/2005.

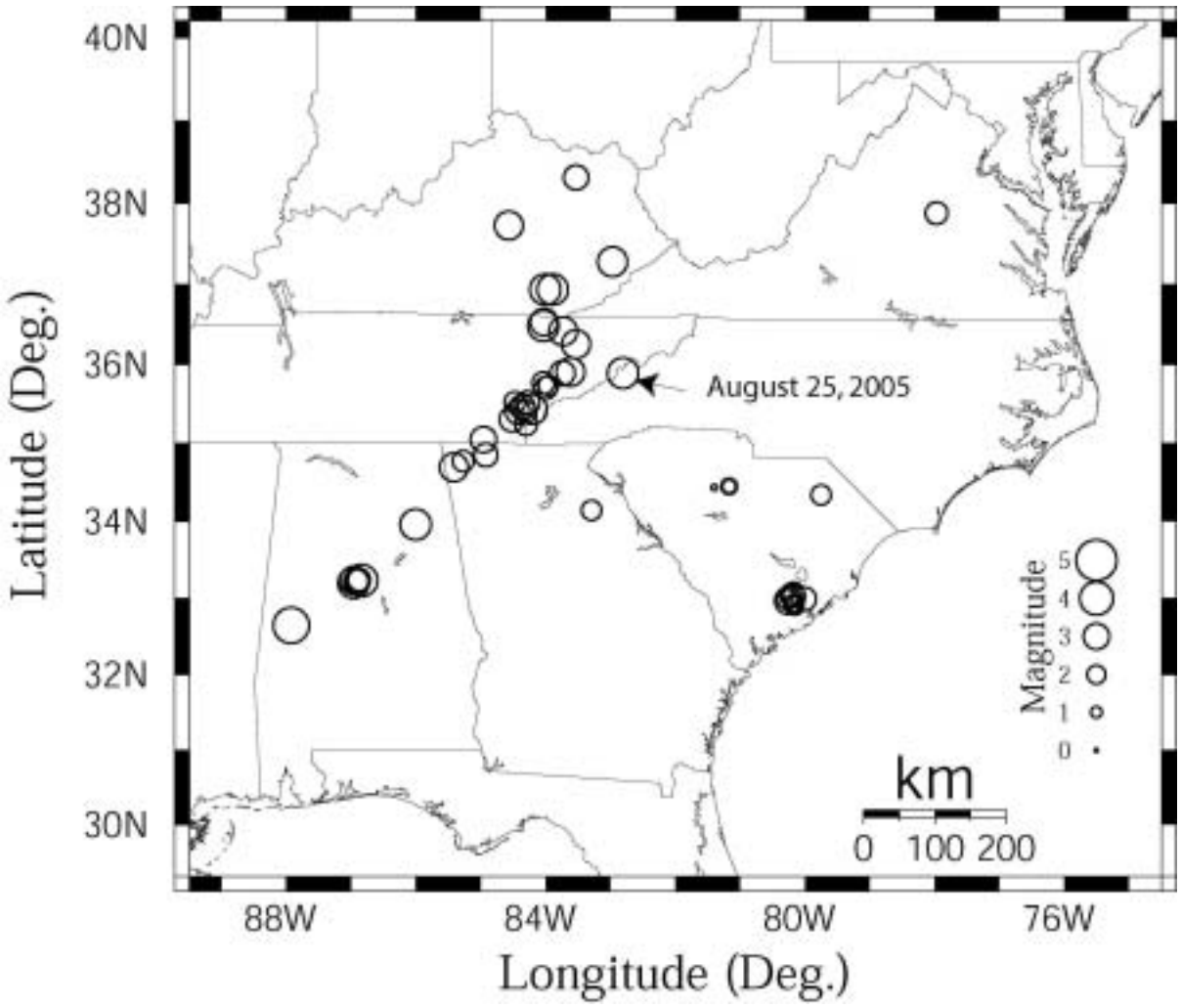

Figure 3. Epicenters of earthquakes occurring during 2004-2005. Events in 2004 are contained in the Southeastern U.S. Seismic Network Bulletin No. 39.

The main event of interest during this time period is the Hot Springs, North Carolina shock of August 25, 2005. The magnitude (Mw) 3.7 earthquake occurred in the Blue Ridge of western North Carolina at 03:09:42.0 UTC Aug. 25, 2005. The epicenter determined by CERI and reported by NEIC is 35.88N, 82.80W, depth 8 km. The author estimated the hypocenter at 35.887N, 82.803W, depth 6.0 km, 03:09:41.7 UTC, using a velocity model developed by Vlahovic and others. The nearest station was at 78 km, and the station gap was 138 deg. The error estimates are 1.1 km (seh max) and 1.6 km (sez). Figure 4 shows the USGS community internet intensity map for this event.

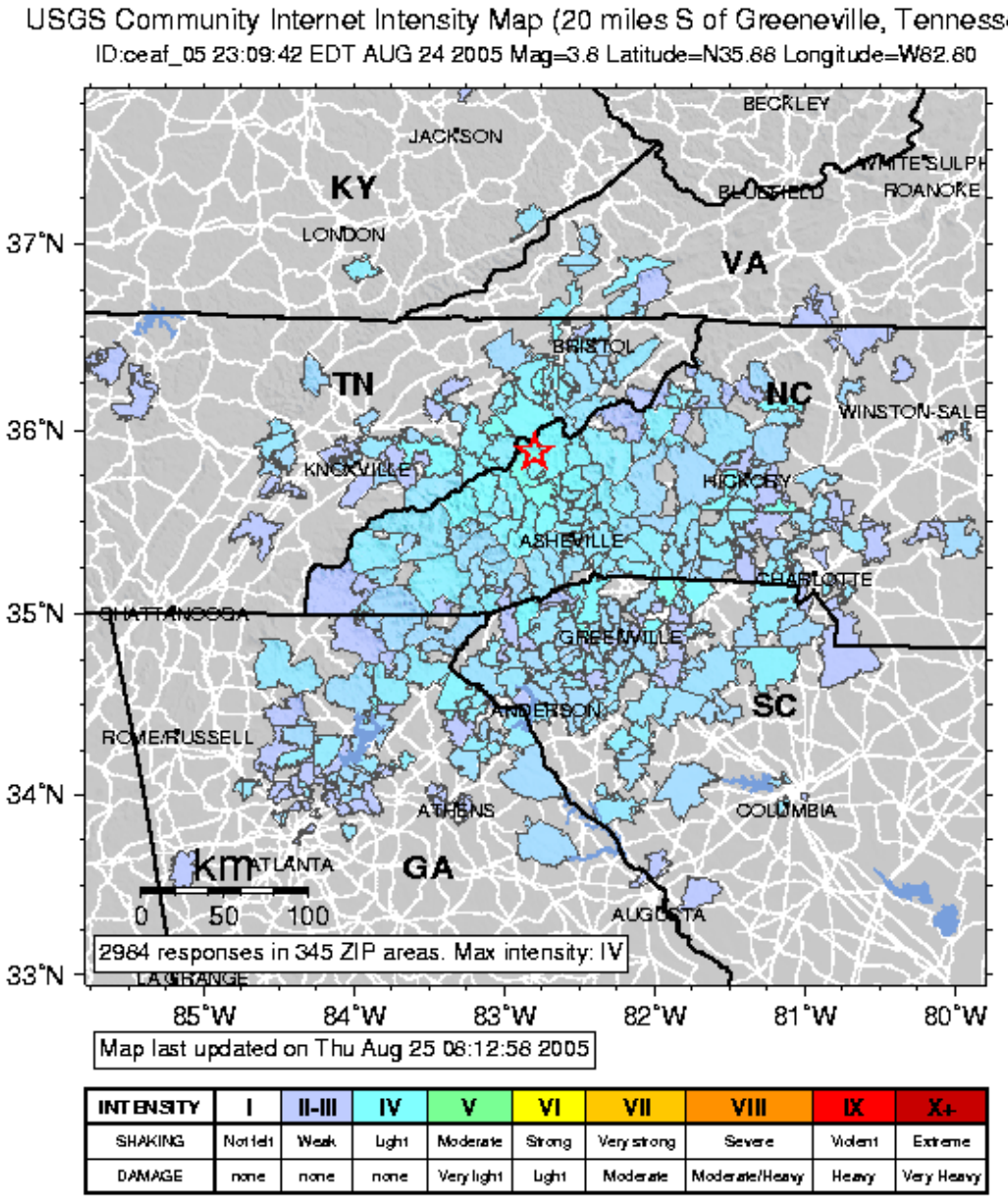

Figure 4. U.S. Geological Survey community internet intensity map of the August 25, 2005 Hot Spring, North Carolina earthquake.

A focal mechanism based on polarities at 31 stations indicates predominately normal faulting on E-W trending nodal planes (NP1: strike N117E; dip 44 deg; rake -60 deg; NP2: strike N259E; dip 53 deg; rake -115 deg). The trend and plunge of the P and T axes are N109E, 69 deg; N7E, 5 deg, respectively. This mechanism is similar to that determined from an inversion of waveform data by Dr. Robert Herrmann at St. Louis University (NP1: strike N90E; dip 60 deg; rake -60 deg; NP2: strike N221E; dip 41 deg; rake -131 deg). Herrmann finds Mw = 3.65 and depth 8 km. Figure 5 shows the first motion focal mechanism derived by the author.

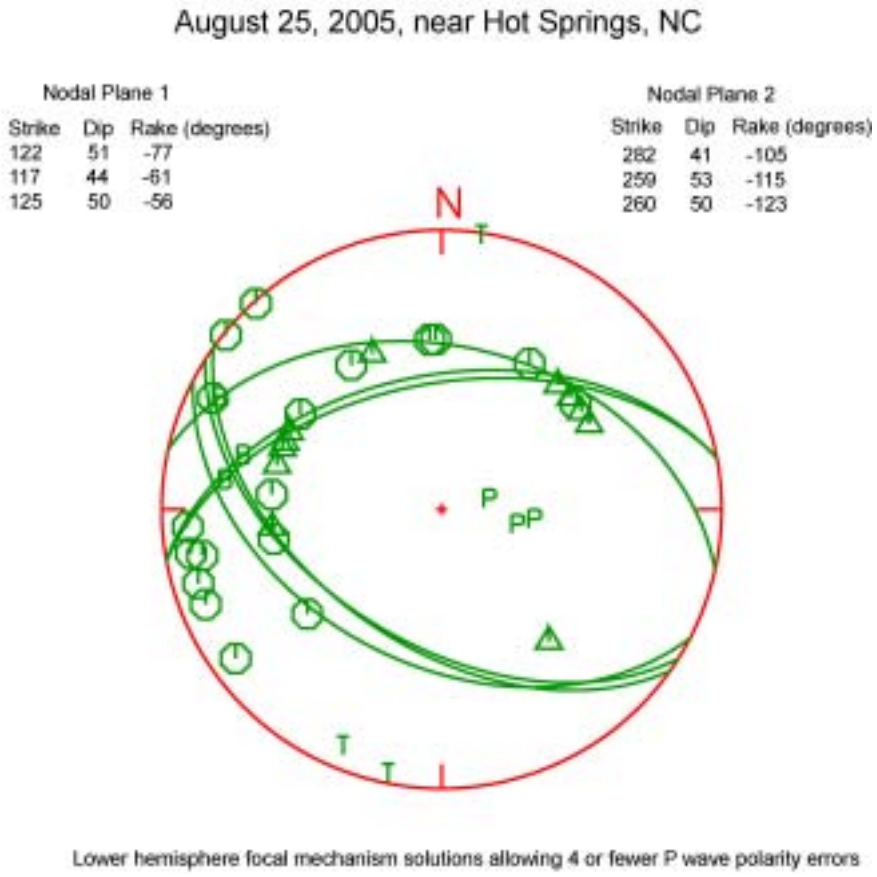

Figure 5. First motion focal mechanism solution of the August 25, 2005 Hot Springs, North Carolina earthquake.

Surface reflections pPmP, sPmP, pPn and sPn were identified by the author on some recordings at ranges greater than 115 km (figure 6). A least-squares fit to the arrival time differences indicates a depth of 5.5 km.

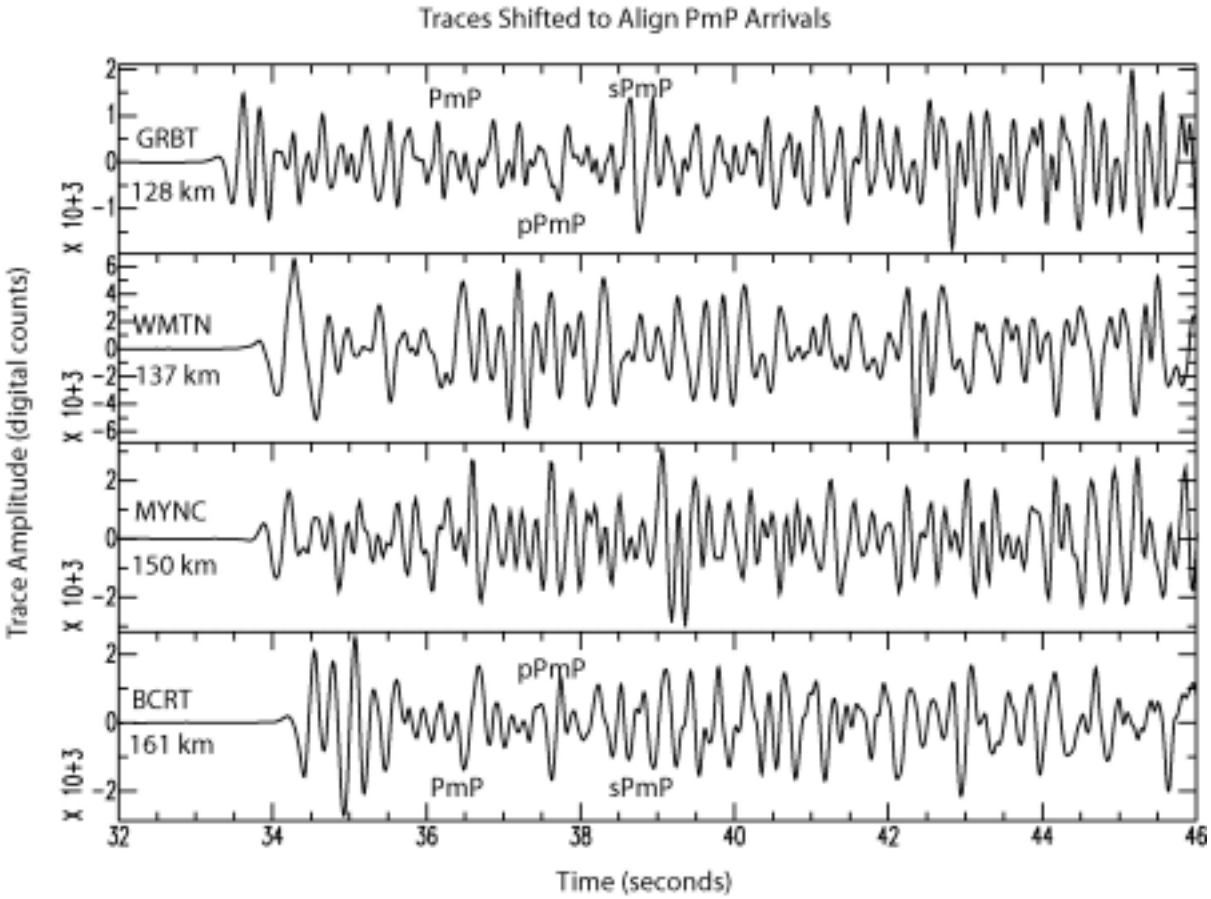

Figure 6. Seismograms of the August 25, 2005 Hot Springs, NC earthquake time-shifted to align PmP arrivals in the distance range 125 to 165 km.

The shallow depth and sub-horizontal T axis contrast with previous findings from the eastern Tennessee seismic zone (ETSZ) to the west. Shocks in the ETSZ (in the Valley and Ridge geologic province) occur in the depth range 5 to 22 km with E-NE trending, subhorizontal P axes (predominately strike-slip).

The epicenter is 2 km east of Hot Springs, noted for its thermal springs. The town lies in the water gap cut by the French Broad River as it flows through the Blue Ridge from SE to NW. The surface geology is complex. The epicenter plots on an E-W trending fault, previously interpreted as part of a thrust window. The thickness of the detached Precambrian and Paleozoic rocks here is 8 km, inferred from seismic reflection profiling.

NONTECHNICAL SUMMARY

The Virginia Tech seismic network contributes to the earthquake monitoring of the southern Appalachian region of the southeastern United States. Data exchange with collaborating institutions is real-time, continuous. Data products generated by the project during the report period are available on-line, including waveform data for Virginia earthquakes, instrumental earthquake catalogs and a historical catalog of events in the southeastern region. On-line helicorder displays for the vertical component stations are also accessible at web site **www.geol.vt.edu/outreach/vtso**.

REPORTS PUBLISHED

The 38th volume of the Southeastern United States Seismic Network Bulletin for events occurring during the 2003 calendar year was distributed to over 100 institutions and individuals in December, 2004. The bulletin contains complete phase arrival time data from all stations recording each tectonic earthquake, as well as much additional information on southeastern U.S. seismicity and network operation. Text versions of the Southeastern U.S. Seismicity Bulletins can be obtained electronically at the Va Tech website, or by anonymous ftp, at the address/URL cited above.

The 39th volume of the Southeastern United States Seismic Network Bulletin for events in calendar year 2004 is currently be finalized and will be distributed in December, 2005. Hypocenter locations for 2004 events have already been forwarded to the ANSS catalog (see below).

A paper entitled "The 9 December 2003, Mw 4.3 Central Virginia, Earthquake: A Complex Event in the Central Virginia Seismic Zone", by Won-Young Kim and Martin C. Chapman appears in the December, 2005 issue of the Bulletin of the Seismological Society of America.

The ANSS Composite Catalog **(http://quake.geo.berkeley.edu/anss/)** currently contains the listing of instrumentally located tectonic earthquake hypocenters and magnitude estimates for the southeastern US region, complete through 2004. Phase arrival time data for events are available on-line in the electronic versions of the SEUSSN bulletins, at the Virginia Tech anonymous ftp address (vtso.geol.vt.edu) or via the website http://www.geol.vt.edu/outreach/vtso/.

Bibliography of Published Reports during Report Period:

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